Relevance of HPC In Today's Challenging Economic Times

"Connecting the Dots"

Dec 10, 2008

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Agenda

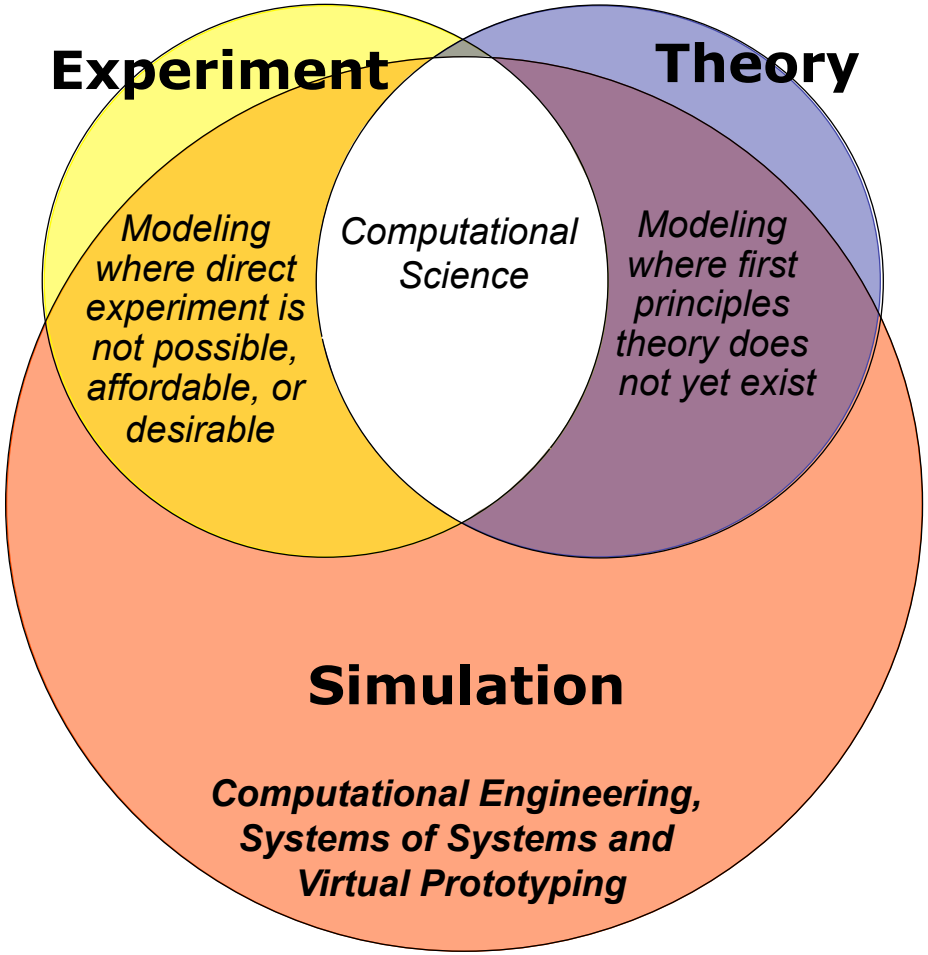
- Relevant Findings to-date
- DARPA DoD Supply Chain Project
  Why is DARPA concerned about competitiveness?
- Current small scale project examples

Building the Business Case

In Cooperation with NSCA, SDSC, PSC, and P&G

Vision for Future

Simulation as a Key Third Pillar for Science



Moving Simulation toward broad acceptance throughout scientific research and industry - greatly informing theory and experiment and even replacing some experiments

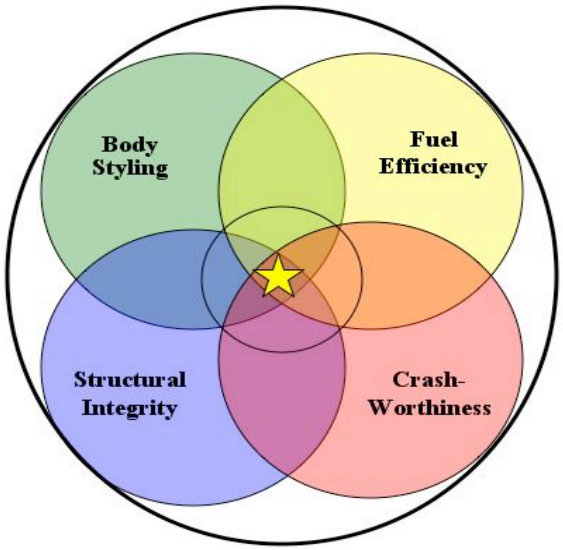
80 fold increase in computing since 2002

Bigger, more accurate models – positioning the United States to sustain its computational leadership and economic competitiveness

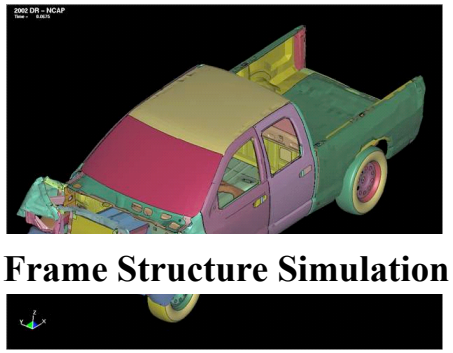
Simulation Based Engineering – Multiphysics

Full Vehicle Design Optimization for Global Market Dominance

Example Requirement Categories	Computational Discipline
Body Styling	3D Full Body Computer Aided Design
Crash Worthiness	3D Dynamic Structural Deformation Analysis
Vehicle Structural Integrity	Finite Element Structural Analysis
Fuel Efficiency	Computational Fluid Dynamics
Passenger comfort (Noise & Vibration)	Acoustic & Finite Element Analysis



Integrated Computational Model Generates Optimal Design

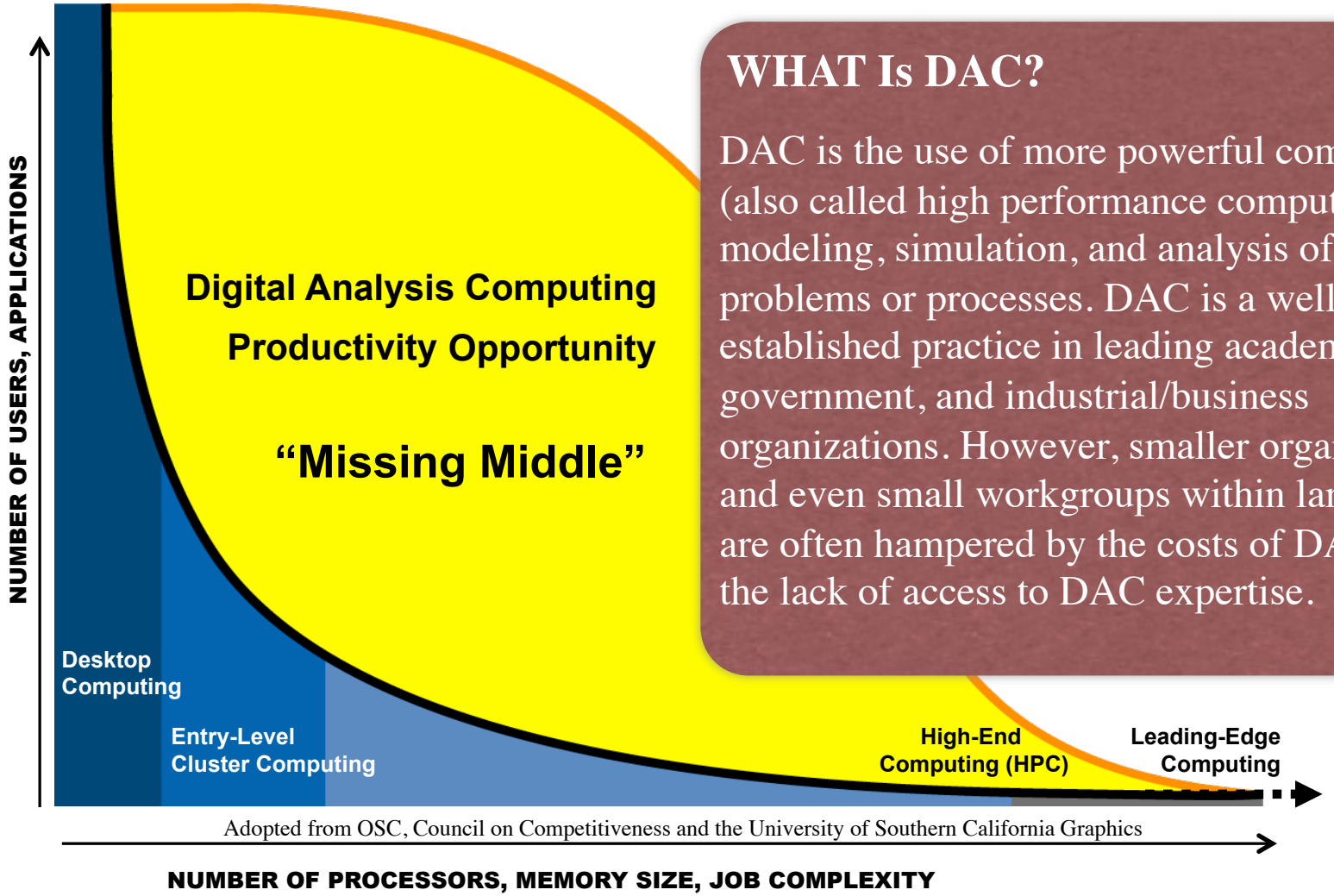


Frame Structure Simulation

Figure 1: Frame from vehicle simulation

Note: Requires lower tier suppliers to have modeling, simulation and analysis capability

Competitiveness Transformation Challenge



WHAT Is DAC?

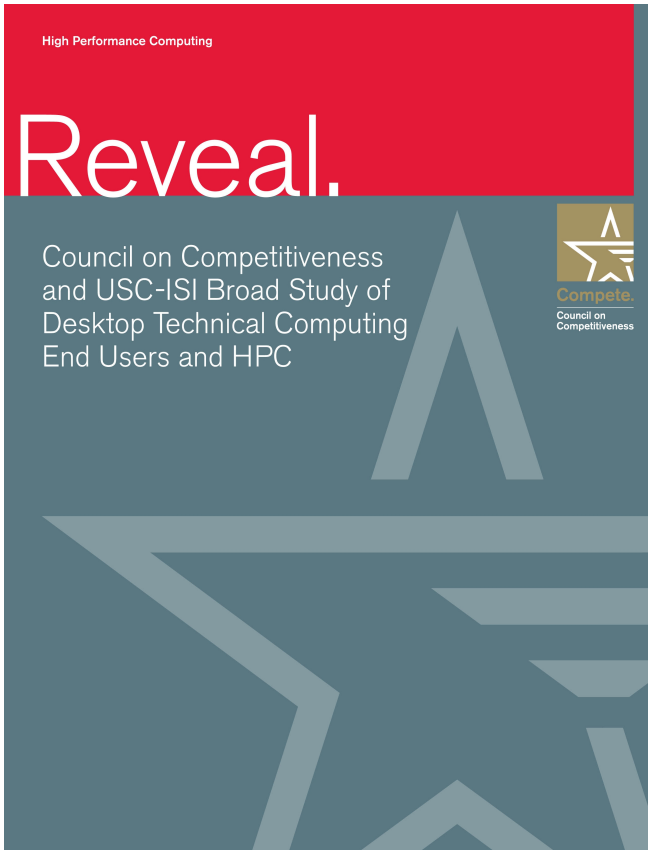
DAC is the use of more powerful computers (also called high performance computing) for modeling, simulation, and analysis of complex problems or processes. DAC is a well established practice in leading academic, government, and industrial/business organizations. However, smaller organizations and even small workgroups within larger firms are often hampered by the costs of DAC and the lack of access to DAC expertise.

Benchmarking Industrial Use of HPC for Innovation

- The first study to benchmark industry's use of HPC to drive innovation for competitive gain.
- Also compares U.S. to international "best-in-class" as well as examines supply chain penetration.
- Confirms that HPC is a proven innovation accelerator.
- Most noteworthy finding: U.S. tier 1 energy firms are outpacing other U.S. industries in integrating HPC into critical business functions beyond R&D.
- Most unexpected finding: Few suppliers to U.S. tier 1 companies in the surveyed industries use HPC (or even desktop workstations) today.

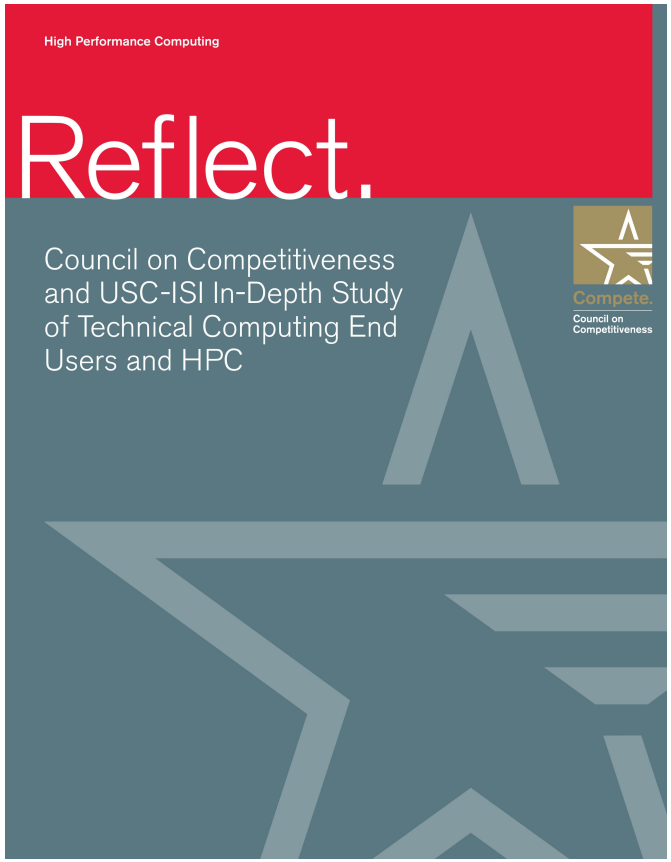
Drivers and Barriers to HPC Usage

- First-ever broad industry survey to examine why "desktop-only" companies have not made the switch to HPC, given their proven competitive benefits.
- Hurdles: Lack of talent, cost issues and a need for application software
- Most of firms revealed they have important problems they can not solve on their desktop systems.
- The survey implications are sobering: critical U.S. supply chains and the leadership of many U.S. industries may be at risk if more companies do not embrace modeling and simulation with HPC.



Drivers and Barriers to HPC Usage

- **BENCHMARKS** the findings from *Reveal* against a group of "desktop–only" and entry level HPC users within a focused industrial sector.
- **CONFIRMS:** even with customer requirements and/or a competitive threat, desktop-only firms still need assistance in overcoming the cost, talent and software barriers impeding HPC adoption.
- **REITERATES:** The important role of partnerships – with university and national laboratory HPC centers and with vendor/ service organizations.



DoD Supply Chain Case Study Example

- **Motivation**

  Understand the barriers to adoption that a desktop-only user within the DoD supply chain has encountered with HPC, and determine what business and technical approaches would enable their future use of HPC.

- **Company Description**

  Company A is a $80M, 230-person supplier of fuel injection systems for commercial and military applications.

- **Key Findings**
  - Company A is a major subsystems supplier of fuel systems to DoD supply chain vendors such as Company B, and is often in the critical path of the design cycle for new systems.
  - Company A designers scale down simulation models to fit on the desktop because of lack of expertise, software, and computing.
  - Stand-alone single-physics simulations lead to ***turn-backs*** (internal redesigns) and ***design escapes*** (external recalls).
  - Company lacks the IT expertise to ***make a convincing ROI argument to management*** or to even use HPC tools if they acquired them.

- **Missed Business Opportunities**
- ***Design turn-backs*** lead to additional design cycles and expensive physical prototype fabrication and testing.
- ***Design escapes*** result in costly product recalls and field service interruptions.
- Delays at Woodward effect the ***design schedule*** for the entire supply chain.
- Limited HW & SW forces Company A to trade R&D for production during peak business, thus sacrificing long-term competitiveness for short-term revenue.

Small Business Case Study Example in Ohio

- **Motivation**

  Understand the barriers to adoption that an experienced engineering services company has encountered with HPC, and determine what business and technical approaches would enable their use of HPC in the future.

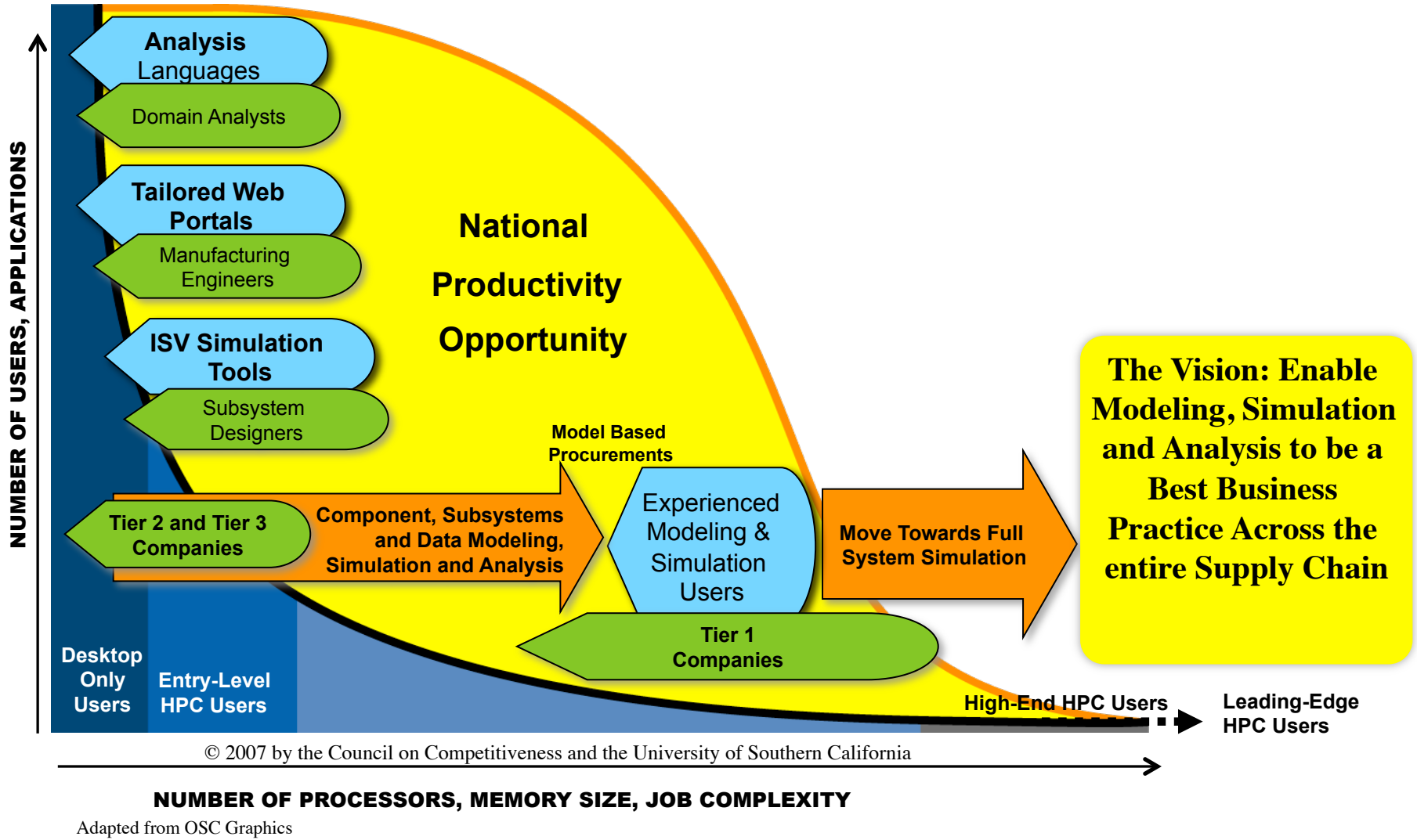
- **Company Description**

  Company X is a five-person firm that provides a broad spectrum of design engineering services and consulting.

- **Key Findings**
  - X often serves as an extension of clients' staff, adding design capacity or a new capability for short-term projects.
  - X differentiates itself by tackling complex multidisciplinary problems by building ***customer-tailored software solutions*** that bridge single-discipline commercial software packages. X has HPC modeling and simulation expertise on staff, but is unable to use it in the business because of cost.
  - Other than payroll, software is X' largest expense today. From their perspective, "stratospheric software cost" is the main barrier to HPC adoption, with hardware costs and technology obsolescence as secondary concerns.

- **Missed Business Opportunities**
- X has turned away business because of the lack of HPC capability for complex simulation models.
- X decides what software to purchase based on amortized usage across multiple projects. It turns down business if the software requirements are incompatible.
- Contention for rationed software licenses and limited desktop computing resources is often a schedule bottleneck.

DoD Supply Chain Community Challenge



Adapted from OSC Graphics

HPC-ISP Pilots - DoD Supply Chain Innovation

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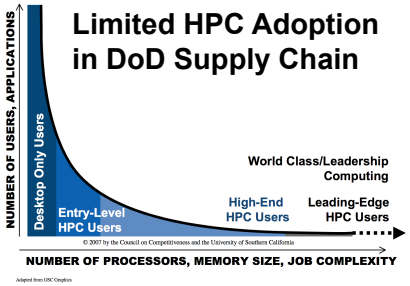
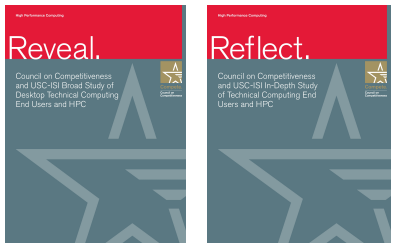


- *The limited industrial user adoption of HPC is eroding the competitiveness of critical DoD suppliers and the country's industrial and military capability.*

NEW INSIGHTS

Phase 1 Case Studies Found:

- *HPC is often **perceived** as an ultra high-end technology appropriate only for government or academia.*
- *There is a lack of understanding of the business value (**ROI**) of simulation and analysis with HPC.*
- *Access to talent, lack of software, and initial capital cost are all barriers.*

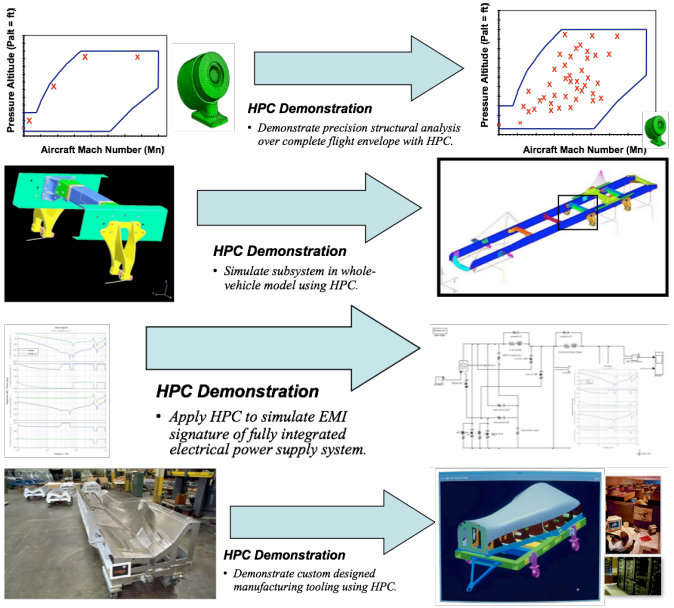


Technical Approach:

- Demonstrate the business and competitive value of product simulation and analysis with HPC for U.S. manufacturing.
- Motivate usage of this innovation-accelerating technology throughout the DoD supply chain supplier base.
- Identify technologies and partners that can help support an HPC infrastructure for the DoD supply chain base.

Deliverables

- Conduct four 12-month HPC pilot demonstrations with DoD supply chain "desktop-only" companies.
- The Council will deliver 10 HPC user case studies.

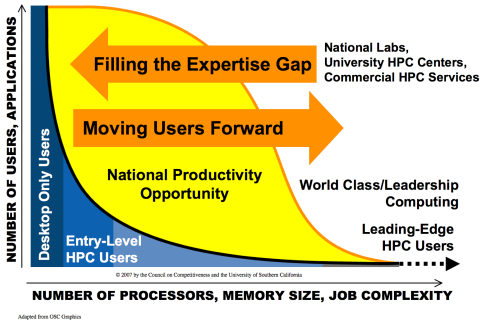


QUANTITATIVE IMPACT

Success Stories:

- Successful examples of accelerated innovation, new discoveries, new product development, shortened time to market, cost savings.
- The Pratt & Whitney supply chain pilot will be measured in terms of value achieved/saved through a product value stream analysis.

END-OF-PHASE GOAL



Strengthen the DoD's Supply Chain

- *Provide real world industry examples of the value of simulation and analysis with HPC that will stimulate usage through DoD's supply chain for greater supply chain reliability, product innovation, and cost savings.*

Drive HPC Usage Throughout the DoD Supply Chain

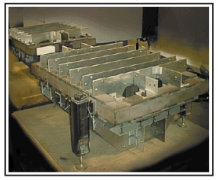
ACE Clearwater Enterprises Pilot - Virtual Metal Form Prototyping

STATUS QUO

Complex Ducting Assembly
Forming - Aluminum Welding
Tube Bending - Assembly

Exotic Metal Forming
Complete Assembly
X-Ray Quality Welds - Machining

Multi-Discipline Assemblies
Forming - Spinning - Bending
Welding - Machining



Total Tool Capabilities
Design - Models - Fabrication
Qualification

Reliance on Physical Prototypes

- *Limited use of computer models leads to multiple iterations of physical prototyping in order to verify that the complex formed metal components meet customer requirements.*

NEW INSIGHTS

Opportunities

- Enabling HPC usage at ACE would **reduce the number of physical prototypes** used and shorten the manufacturing cycle.
- HPC expertise is a major barrier, but **small companies trust local regional universities** to provide workforce training and expertise.

Pilot Description

- ACE Clearwater Enterprises builds complex formed and welded assemblies for the aerospace and power generation industries. Key aerospace customers include Lockheed Martin, Sikorsky, Boeing, Textron/Bell, and Northrop Grumman.
- ACE provides a "build-to-design" service specializing in complex formed and welded assemblies with performance requirements that are validated using physical prototyping and limited desktop modeling.
- This pilot will demonstrate how HPC can reduce a small company's reliance on physical prototyping and shorten the manufacturing cycle of DoD components.

Technical Approach

- ACE Clearwater will participate in design clinics at Cal. State Los Angeles, where honors students will build HPC solvers for real-world manufacturing problems with ACE professional engineers and HPC mentors from USC.
- The pilot will host MSC Software's SimDesigner modeling and simulation package on a network of low-cost Microwulf HPC machines.
- A case study of ACE Clearwater Enterprises and an HPC supply chain potential impact analysis for the Los Angeles region will be performed.

Milestones and Deliverables

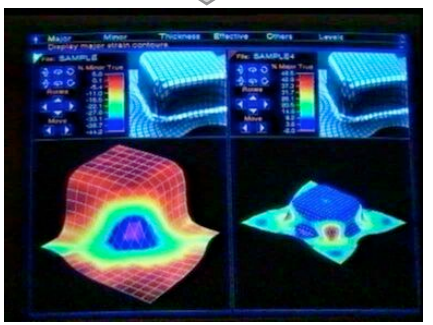
- **Month (April 2009) -** prototype analysis at Cal. State, L.A.
- **Month 12 (July 2009) -** ACE Clearwater real world HPC "success story" case study and supply chain analysis.

QUANTITATIVE IMPACT

Impact

- Compelling real world "success" story that describes the tangible benefits and competitive gains that small companies can achieve from using HPC modeling and simulation.
- Reduction in the number of physical prototypes by 50% through HPC-driven modeling and simulation.
- Development of a trusted regional delivery mechanism for HPC workforce training thru California State programs.

END-OF-PHASE GOAL



HPC Demonstration

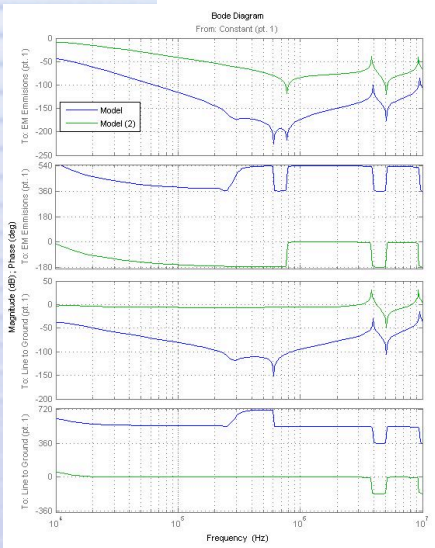
- *Demonstrate virtual metal form prototyping using HPC.*

Reducing Physical Prototypes Through High Performance Computing

Reduce The Amount of Physical EMI Testing
Power Node Control Center for DDG-102 RADAR Room

EMI - Traditional impact

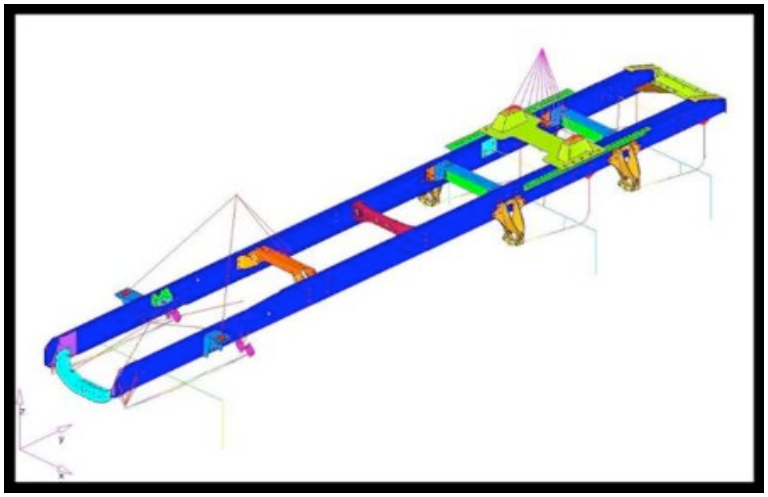
- ~$40,000 per test
- ~$100,000 and 4 months to correct violations
- Testing is time consuming
- Solution often not valid over required frequency range
- Exemptions and waivers are often sought



A | C | E | S Advanced Computational & Engineering Services

Chassis Weight Reduction for HMMWV
Composites DOC LLC

- Reduce weight by 2,500lbs!
- Maintain or exceed current performance
  - Structural integrity
  - Durability/Reliability
  - Vehicle Dynamics



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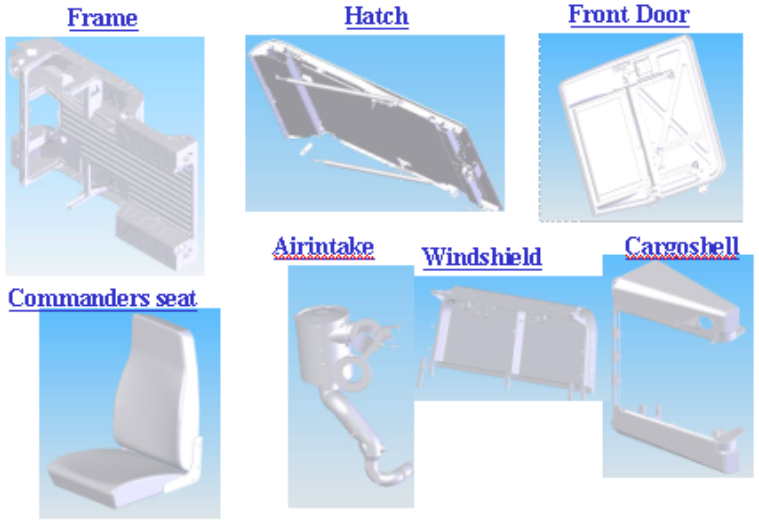


If HPC "Digital Analysis Computing" Is a Game-Changing Technology for Everyone!

Then

How does one Lower the Entry Barriers?

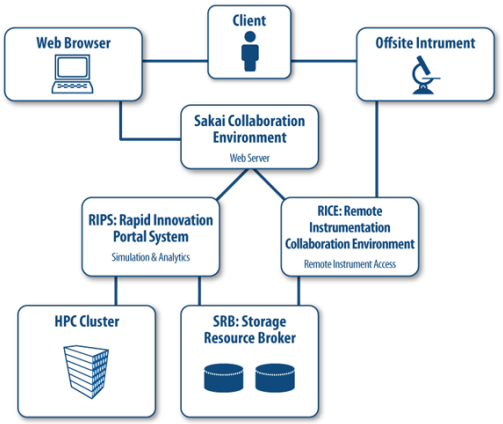
Everyone has a Role!

Regions Lead, Augmented by Seamless Access to National Resources

Regional Blue Collar Computing Example - OSC

- Shared, statewide services and technology leadership
  - **High performance computing** resources for all public and private higher education institutions
  - New collaborations for **computational science education** and **workforce development**
  - Renewed focus on **economic development through Blue Collar Computing and networking for businesses**

- BCC Example: Polymer Portal in collaboration with PolymerOhio
- Polymers and plastics is a large industry in Ohio (2800 companies, 175,000 employees)



Empower. Partner. Lead

Ohio Supercomputer Center

Example of a National Computing Brokerage Service

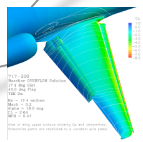
Nimbis Services Inc. www.nimbisservices.com

1. They act as a clearinghouse for buyers and sellers of Digital Analysis Computing (DAC) services.
2. They provide pre-negotiated access to high performance computing services, software, and expertise from the leading computer time vendors, independent software vendors, and domain experts.
3. They partner with the world's leading computing services companies to provide experimental and periodic users with a choice growing menu of pre-qualified, pre-negotiated services from HPC cycle providers, independent software vendors, domain experts and regional solution providers, delivered on a "pay-as-you-go" basis.
4. They make it easier and more affordable for desktop users to exploit DAC for faster results and superior products and solutions.
5. They enable Tier 1 firms to drive enhanced productivity, cost-efficiency and innovation through their supply chains.
6. They provide access to new users and markets for core services providers.

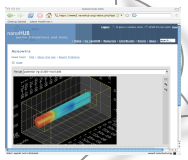
Example - Ohio Supply Chain Pathfinder Pilot

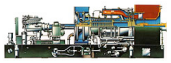
Supercharge Economic Growth through Competitive Computing

Solution Centers



OSC Blue Collar Computing





Technology, Rapid Prototyping, Design Simulation Centers

ACES

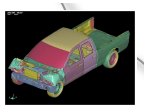
Large Ohio firms (P&G, Goodyear)

Associations, Institutes, Economic Councils

PolymerOhio

OMA

EWi



NAM

Ohio Manufacturing Supply Chains

Nimbis Services: Industry Gateways, Services, Resources, Expertise

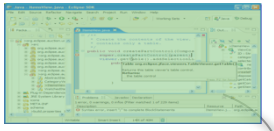
Education and Training

MEP

OSC RRSCS

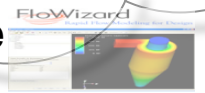
K-12

Community Colleges

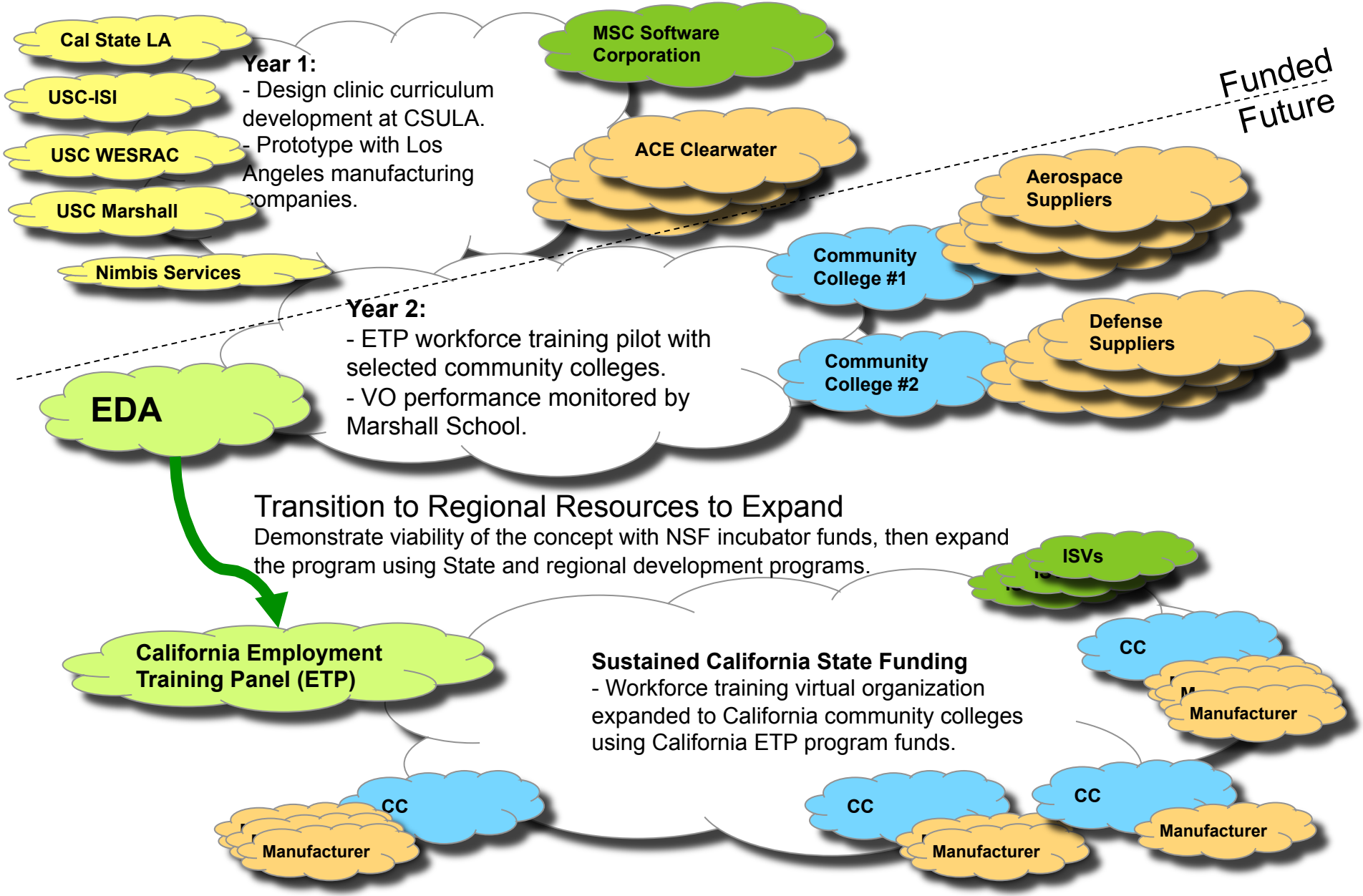


ACES

Public Broadband Infrastructure



California, LA, Virtual Prototyping - Talent Development Example



Discussion